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# WHAT EVER HAPPENED TO THE PHILLIPS CURVE?*

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# WHAT EVER HAPPENED TO THE PHILLIPS CURVE?

Any consensus that may have existed at the beginning of the last decade concerning the Phillips curve (PC) has disappeared. While the notion of a PC continues to influence discussions of a potential trade-off involved in anti-inflation programs, detailed discussion of a PC or popular use of the term "Phillips Curve" appears to have lost currency in public policy discussions and in the literature.

In part, the devaluation of the PC during the last decade arose from the increased attention given to its transitory nature [following Friedman (1968) and Phelps (1967)]. More important, however, inflation and unemployment developments over the past decade appear to stand in marked constrast to the inverse pattern observed in the prior data (see Chart 1). More recently, the so-called "consensus view" of the systematic short-run relationship between unemployment and inflation has been questioned and reinterpreted by Barro (1978), Stein (1978) and Tatom (1978a). Some analysts have argued that the concept of the PC, circa 1970, has proved useful and largely correct, subject to the qualification that some new characteristics have been discovered [Perry (1980) and Tobin (1980)].

The purpose of this paper is quite modest. First, a simple explanation of some major differences in theoretical discussions of the PC is presented, second a hypothesis is developed that there is no systematic relationship between inflation and unemployment. According to this view, there can be a transitory appearance of such a systematic relationship. This hypothesis is tested below. The evidence is supportive of the hypothesis. Moreover, the estimates provide evidence that, in the absence of price controls and energy price developments in the last decade, monetary policy was sufficiently erratic so that a transitory inverse empirical relationship would have been more apparent. Thus, it remains reasonable to expect inverse movements in inflation and unemployment rates, under certain conditions. This is the limit, however, of the extent to which one might conclude that the Phillips curve has survived the past decade.

## The Theoretical Issues

The literature on the PC has become very disjointed in recent years so that it is doubtful that agreement can be reached on the theory or conceptual tradeoff embodied in the PC.[1/] Tobin (1980 p. 23-25) recently presented a vintage 1970 "consensus view" of the PC that is essentially the expectations-augmented PC, including the natural rate hypothesis. His summary implicitly indicates that the consensus was already breaking down at that time. For example, Tobin claims that the consensus held that changes in aggregate demand affected the "course of prices, output, and wages and employment, by altering the tightness of labor and product markets, _and in no other way_." (p. 24, emphasis added). The determination of prices by the interaction of supply and demand was regarded by many as an important framework even in 1970 so that Tobin's description does not qualify as a consensus. In particular, the Friedman-Phelps contributions had already shown that alternative positions on an essentially vertical long-run PC were related to the course of aggregate demand and independent of the degree of transitory slack in the economy.

Tobin mentions (p. 24) the Phelps-Friedman natural-rate hypothesis as part of the consensus model, but then appears to identify the natural rate with the "non-accelerating inflation rate of unemployment" (NAIRU). The notion of a NAIRU does not follow from the natural rate hypothesis. For many theorists in 1970 it was simple to understand how growth in aggregate demand could be pushing up an expectations augmented short-run PC and the inflation rate, even if considerable slack existed in the economy.

The identification of a NAIRU with the natural rate added a corollary about the dynamics of the Phillips curve that was not a part of the consensus view in 1970. The NAIRU was popularized later by Modigliani and Papedemos (1975), Gordon (1976) and Perloff and Wachter (1979). The experience in the past decade makes the NAIRU corollary highly doubtful.[2/] As Chart 1 indicates, inflation accelerated in 1973, 1974, 1977, 1978, 1979 and 1980. Except for the first two instances, the unemployment rate in the prior year (or the current year) was well above estimates of the natural rate. Similarly, in 1971, 1972, 1975 and 1976 inflation decelerated, while in 1971-72 the unemployment rate was at the lowest levels achieved in the last decade.

Disagreements have long existed concerning the appropriate determinants of aggregate demand and supply and the mechanism through which these determinants affect the equilibrium and/or expected inflation rate in the Phillips curve. More recently, the divergence in the literature concerning whether the long-term PC is essentially vertical at a labor market determined (largely based on demographics) natural rate or at a NAIRU has further obscured the concept of the PC.

Tobin (1980) explains the recent experience of the PC arguing (1) that the unemployment rate at which the PC is essentially vertical is highly variable and contains "a significant proportion of involuntary unemployment" (p. 65) and (2) that the equilibrium inflation rate associated with a vertical PC is also unstable, if, indeed, it can be referred to as an equilibrium at all.[3/] In effect, equilibrium points that constrain the position and shape of the short-run PC are dismissed for both the inflation and unemployment planes. By setting the short-run PC free again from longer-run equilibrium considerations, it is free to float in two-space, influenced by demand management policies, but ultimately controllable only by income policies.

Another significant development in the PC literature in the last ten years has also confused the theoretical and empirical issues surrounding the PC. This work calls attention to the inherent endogenity of both inflation and unemployment and explains the sometime appearance or nonappearance of an inflation-unemployment trade-off by the dynamics of adjustments to equilibrium arising from aggregate demand or supply changes. Recent examples of such work include Barro (1978), Stein (1978), and Tatom (1978a). The thrust of these papers is that an apparent trade-off arises from differences in the timing and magnitude of responses of inflation and unemployment to changes in monetary growth rates.

## The Inflation-Unemployment Hypothesis

A reduced-form macroeconomic approach sheds some light on the major departure of annual PC points from the earlier inverse pattern.

This approach draws upon the model used in Tatom (1981). The central features of that model are that the growth rate of nominal GNP is determined by current and past movements in monetary and fiscal variable with some transitory influence arising from supply shocks such as major strikes or energy price shocks. Expected and actual inflation rates are determined by the growth of aggregate demand relative to the growth of aggregate supply. In this model, real output growth is largely determined by the growth of potential output and lagged effects due to cyclical responses to policy actions. Unemployment rate developments reflect the cyclical movements in actual output relative to potential growth that occur due to changes in monetary growth rates. In this sense, unemployment is tied to a natural rate that is largely associated with demographic labor market characteristics and not a NAIRU level. Tatom (1981) specifically accounts for the influence of the price-control program and energy price shocks in such a model. Using this approach, it is possible to assess the impact of these shocks on the PC experience in the decade of the seventies.

The inflation equation estimated for the period I/1955-IV/1980 is:

$$\dot{P}_t = \underset{(28.31)}{1.019} \sum_{i=0}^{20} w_i \dot{M}_{t-i} \underset{(-4.04)}{-2.05}\, D1 + \underset{(2.49)}{1.226}\, D2 \qquad (1)$$

$$+ \underset{(0.40)}{0.005}\, \dot{p}^e_{t-1} + \underset{(2.66)}{0.043}\, \dot{p}^e_{t-2} \underset{-(0.56)}{-0.009}\, \dot{p}^e_{t-3} + \underset{(2.09)}{0.028}\, \dot{p}^e_{t-4}$$

$$\bar{R}^2 = 0.78 \qquad S.E. = 1.17 \qquad D.W. = 1.63$$

where $\dot{P}_t$ is the annual percentage rate of increase in the GNP deflator in quarter t, $\dot{M}$ is that for money (M1B), and $\dot{p}^e_t$ is that for the relative price of energy. D1 and D2 are price control/decontrol dummies where D1 = 1 in III/1971-I/1973, D2 = 1 in I/1973-I/1975, and both are zero in other periods. The current and lagged money growth coefficients are estimated using a third-degree polynomial with a tail constraint of zero. Tatom (1981) discusses experiments with other policy and shock variables that might be expected to enter such a reduced form equation but that are omitted due to a lack of statistical significance.

There are four principal characteristics of this equation. First, in the absence of energy price shocks and price controls, the U.S. rate of inflation of the GNP deflator tends to equal the trend rate of money stock growth over the past five years; that is, the sum of the current and lagged coefficients on money growth is not significantly different from unity. Second, an insignificant constant is omitted indicating that the growth rate of velocity equals that of potential output. This is consistent with the notion that efficiency in the payments system in the U.S. has grown at roughly the pace for the economy as a whole. Third, price controls exerted a negative temporary impact on inflation rates observed in 1971-73 and the breakdown of controls led to a subsequent return of the price level to the path it would have followed in the absence of controls. By 1975, the depressing effects of controls had been offset by a post-control surge in prices. This result has been observed by numerous observers, including Karnosky (1976), Gordon (1977), and Blinder and Newton (1981). When the price equation is run with the control effect constrained to zero, (D2 = 7/9 D1), the F-statistic (1,95) for this constraint is 0.18, not significant at the 5 percent level.

None of the other coefficients or summary statistics is affected. The control effect is -1.85 percent (t = -3.93) for the 6 quarters from III/1971-IV/1972. The average increase in inflation during the eight quarters II/1973-I/1975 is 1.44 percent.

Finally, an increase in the relative price of energy raises the general level of prices in proportion to the decline in the level of productive capacity in the economy as hypothesized by Karnosky (1976), and Rasche and Tatom (1977a, 1981). In the inflation equation above, the sum of the energy price coefficients is 0.07 (t = 3.20). The effects of energy price increases in the 1970s on quarterly inflation rates are shown in Chart II.

The inflation rate equation can be used to decompose the actual inflation experience into monetary, control, and energy price components. To do this, equation (1) is simulated from I/1969 through IV/1980 to generate quarterly inflation rates and price levels assuming (1) actual experience for the independent variables, (2) the absence of changes in the relative price of energy and controls, (3) the absence of energy price changes, and (4) the absence of controls. The results of these simulations for annual rates of inflation are summarized in table 1.

The unexplained column is the actual inflation rate minus the simulated inflation rate using the actual pattern of money stock growth, controls, and energy price changes. Except for the fairly large error in 1979, the mean and standard error of the residuals are small, +0.1 percent, and 0.6 percent respectively. The column labeled the monetary inflation rate is derived setting the control variables and energy price change variables at zero from I/1969 to IV/1980. The control effect is the difference in the simulated inflation rates using actual money growth only and actual money growth with actual control dummy variables. The energy price effect is the difference in the simulated inflation rates considering money growth alone and money growth and energy price changes.[4/] The results in table 1 indicate that controls and energy price increases in the last decade had large temporary effects on the rate of price increase, especially in 1974-75 and 1980.

A standard PC view can also be tested using the inflation rate equation above. Since there is an obvious lack of consensus concerning the theory, some elaboration of the hypothesis to be tested here is in order. Suppose that labor market dynamics are such that real wages adjust in a manner that insures that a characteristic of macroeconomic equilibrium is a natural or full employment level of the unemployment rate. Assume that the equilibrium inflation rate is determined by macroeconomic policy actions that influence the growth of aggregate demand relative to aggregate supply but that, in the short-run, the growth rate of nominal wages are influenced by the extent of slack in the economy. If slack is measured by the excess of the unemployment rate for the civilian labor force over a demographically adjusted full-employment rate of unemployment, then it may be the case that slack influences observed inflation rates in a systematic inverse manner.

To test this view, the difference between the unemployment rate and a measure of the full-employment unemployment rate is added to the inflation equation above. As observed in Tatom (1978a), such a variable does not add significantly to the equation (t= -0.79). Since some analysts use the inverse of this slack measure the equation was reestimated in that fashion. Again the slack variable is insignificant, t = 0.65. While, the absence of significance is not a monetarist proposition [see Anderson and Carlson (1970) or Cagan (1978) for monetarist approaches that include a short-run Phillips Curve], it does reinforce the importance of a monetary explanation of inflation.

An Opposing View

Perry (1980, p. 233) questions the view that monetary growth is the primary determinant of inflation. Instead, he claims that when "the simplest standard Phillips curve variables "are added to a reduced form such as that above, the sum of the money growth rate coefficients is zero and that "money growth contributes nothing to the equation." He concludes that "there is no evidence that money growth offers a shortcut to disinflation" compared to his model. A casual review of his evidence shows that this position is misleading.[5/]

Perry's investigation concerns estimates for the rate of increase of the personal consumption expenditure (PCE) deflator. He contrasts the results including only money growth with an equation that adds the inverse of his measure of excess unemployment, lagged inflation and his "norm shift dummy," that captures changing wage-setting behavior in the seventies. His "best" equation for the period I/1954-IV/1979 has a standard error of 1.34 percent and an adjusted $R^2$ of 0.77. In this equation, the only variable with a t-statistic larger than 1.5 is that on lagged inflation; that is, neither slack, the new dummy variable, nor money significantly affects inflation. Even if the Phillips curve variables were significant, this equation would not offer a suitable test of a monetarist view, since the past history of monetary growth is fully reflected in the lagged inflation rate.[6/]

Nonetheless, the inflation equation above was estimated using the rate of increase in the PCE deflator as the dependent variable for the period examined by Perry (I/1954-IV/1979). A second degree polynomial with a zero tail constraint was used to estimate the current and twenty lagged coefficients on money growth. The price control dummies are included and the current and two lagged values for movements in the relative price of energy are included. Thus, the equation includes five variables not in Perry's equation and excludes four of his (97 instead of 98 degrees of freedom). The standard error of this equation is 1.27 percent, a significant improvement over Perry's equation. Adding the inverse of excess unemployment to the equation worsens the standard error as the t-statistic for the added variable is less than 0.5. The size and significance of the other variables is unaffected by this addition.

It is possible to improve on this inflation estimate since the optimal lag length for money growth is shorter than twenty quarters for this measure of inflation and there is significant first-order autocorrelation in the residuals.

A search for the optimal lag on money using the minimum standard error criteria reveals an optimum with current and nine lagged terms for money growth. Again the constant is never significant and D2, the decontrol dummy defined above, is not significant but it is not omitted.[7/] The optimal lag on energy prices was found to be shorter as well. A current and two lagged values of the rate of change in the relative price of energy is optimal for lags on money from seven to twenty quarters. The price equation is:

$$(2) \qquad \dot{P}_t = \underset{(18.55)}{0.87} \sum_{i=0}^{9} w_{t-i} \dot{M}_{t-i} + \underset{(3.04)}{0.04} \dot{p}^e_t + \underset{(1.20)}{0.02} \dot{p}^e_{t-1}$$

$$+ \underset{(2.43)}{0.04} \dot{p}^e_{t-2} - \underset{(-2.60)}{1.76} D1 + \underset{(1.35)}{0.97} D2$$

$$\bar{R}^2 = 0.80 \qquad S.E. = 1.19 \qquad D.W. = 2.11 \qquad \hat{\rho} = 0.37$$

When the inverse of the excess unemployment rate is added to this equation, the coefficient has the wrong sign and the t-statistic is only (-0.22).

When both the slack measure and the lagged dependent variable are added to the equation above, both variables have the correct sign, and the t-statistics on the coefficient for the lagged price term (0.49) is 6.37, but the sum of money growth coefficients (0.45) remains significant t=6.43. The F-statistic for adding only the lagged dependent variable to the equation above is $F_{1,96} = 2.39$, which is not significant at the 5 percent level. Inflation is only a proxy for past money growth.[8/] The F-statistic for the addition of the two variables, slack and lagged inflation, is $F_{2,95} = 1.28$, which is not significant at the 5 percent level. Thus, neither of Perry's variables improves upon the equation above.

These strong results do not appear to be an artifact of the sample period. Perry also reports results for the period I/1954-IV/1969. The experiments conducted above were also conducted for this sample period. Again, the optimal lag on money growth is nine past quarters. The energy price coefficients are not statistically significant but they are included because the variance of the relative price of energy around a negative trend over this period was extremely small (see Rasche and Tatom 1977, p. 16). Also, the sum of the energy price coefficients is not significantly different from that for the longer sample period. The estimate for the period I/1954-IV/1969 is:

$$(3)\qquad \dot{P}_t = \underset{(9.63)}{0.75} \sum_{i=0}^{9} w_{t-i}\,\dot{M}_{t-i} + \underset{(0.49)}{0.02}\,\dot{p}^e_t + \underset{(0.05)}{0.00}\,\dot{p}^e_{t-1} + \underset{(1.80)}{0.05}\,\dot{p}^e_{t-2}$$

$$\bar{R}^2 = 0.32 \qquad S.E. = 1.22 \qquad D.W. = 2.18 \qquad \hat{\rho} = 0.36$$

Again when the slack measure is added to the equation, its coefficient has the wrong sign and is insignificant ($t = -0.39$). When both slack and the lagged dependent variable are added, slack is insignificant ($t = 0.61$), and money growth remains significant ($t = 4.04$). An F-test for the addition of both variables, slack and lagged inflation, rejects their inclusion ($F_{2,56} = 1.63$). Finally, when only lagged inflation is added, an F-test for the addition of the variable rejects (5 percent significance level) its inclusion ($F_{1,57} = 2.93$). It can be concluded that Perry's test of a monetarist explanation of inflation is weak and that his rejection of that explanation is unfounded. A Phillips curve equation is rejected in every test conducted here, slack does not enter the inflation equation.

The evidence indicates that the fit of a reduced-form money equation is as good for consumer price inflation as for the GNP deflator (and superior to a PC estimate). The effects of money growth and changes in the relative price of energy occur faster for consumer prices. Also the sum effect for money growth is slightly smaller, and the sum effect for energy price changes is larger, than in the GNP deflator equation.

## The Unemployment Equation

In the context of a generalized Okun's Law, the unemployment rate (U) equals a full-employment rate ($U_F$) plus a cyclical component related to the GNP gap. Consequently, the excess unemployment rate, $N = U - U_F$, is a function of the gap between the economy's potential and actual real GNP. Changes in excess unemployment are a function of those variables that change the GNP gap, presumably exogenous variables that change the growth rate of aggregate demand or supply. Such a reduced-form equation is discussed in detail in Tatom (1981) and the specification here draws upon those results.[9/] The full-employment unemployment rate is that developed by Clark (1977).

The unemployment rate equation, estimated over the same period as the price equation, is shown in table 2. Such an unemployment equation or one that relates excess unemployment to the GNP gap [see Tatom (1978b)], has serious autocorrelation problems, unless lagged levels of the excess unemployment rate are included to capture persistence effects. Typically, such problems can be avoided by first differencing the dependent variable and using some form of autocorrelation correction. The specification used here has the advantage of suggesting that such autocorrelation arises from the omission of lagged dependent variables rather than other omitted variables or the presence of an autocorrelated error process.

The tests for optimal lags on money growth and energy price changes described in Tatom (1981) were used to find the optimum estimate in table 2. The money growth coefficients are estimated using a third degree polynomial with a zero tail constraint, and the energy price change coefficients are estimated using an unconstrained second degree polynomial. In each case the sum of the coefficients is not significant, nor is the addition of a constant in the various equations estimated. Strike and price control dummies are omitted due to their insignificance.[10/]

Equation (4) is estimated with the coefficients of the lagged unemployment rate terms constrained to sum to one. The F-statistic for the imposition of this constraint is $F_{1,96} = 2.55$, which is not significant at the five percent level. None of the other coefficient estimates, on their significance, is affected by this constraint. The principal effect of the inclusion of the lagged unemployment rates in equation (4) is to lengthen the optimal lag for money growth from ten to fifteen quarters, specifically, by lengthening the period of unemployment increases following a positive increase in money growth from period t+5 to t+9, to t+5 to t+14. The sum of the negative coefficients and positive coefficients, their pattern and significance are virtually unchanged.

Such an excess unemployment equation illustrates the neutrality of money growth as well as the short-run possibilities for an active monetary policy. The pattern of energy price change coefficients indicates that output initially declines less than potential output when there is a positive energy price shock, so that initially excess demand is met by employment increases. Subsequently, the unemployment rate rises and then quickly returns to its original level.

Chart 3 shows the impact of actual energy price changes on the movements in the unemployment rate since 1970.[11/] These quarterly effects are trivial, except during 1974-75 and 1979-81. In both instances, the relative price of energy rose about 40 percent ($\Delta \ln$) but the increase was spread over a year. In table 3, actual movements in the unemployment rate are decomposed into changes arising from monetary policy actions, changes arising due to energy price developments, and an unexplained component. The monetary policy action component and energy price components are found by dynamically simulating the unemployment equation (4) from the first quarter of 1969 on, using the actual experience for money and energy prices, and then assuming no energy price changes. The unexplained component includes increases in the full-employment unemployment rate, rounding error, and the residual error in the simulation.

The energy effect on changes in the unemployment rate is generally quite small, exceeding 0.2 percentage points only in 1975-76 and 1979-80. In contrast, fluctuations in money growth led to larger changes in eight of the eleven years. Of particular importance, in 1975 and 1980 when the positive impacts of higher energy prices were largest, monetary policy actions had turned sufficiently restrictive to lead to unemployment increases larger than those due to energy price increases. In 1976, the effect of monetary restraint was masked by the adjustment to the prior energy shock.

The PC Implications of an Energy Price Shock

Using the results in table 1 and table 3, the combination of inflation and unemployment rate changes that abstract from changes in energy prices and controls during the past decade can be depicted as in chart 4. The estimated unemployment rate is found by cumulating predicted changes in the excess unemployment rate and changes in the full-employment unemployment rate from the first quarter of 1969 through 1980, without actual energy price changes. The unemployment rates shown in chart 4 exclude the energy price induced fluctuations in the unemployment rate.

Removing energy price effects on unemployment and inflation (as well as control effects in 1971-75), restores a normal trade-off between inflation and unemployment. Nevertheless, the upward climb in inflation continues the trend that began in 1964, leading to the departure of the seventies experience from the tighter trade-off combinations shown from 1954 to 1967 in chart 1. The effects of restrictive monetary actions in 1969-70 and 1973-75 raising unemployment are more clearly comparable to the experience in 1958 and 1961. Except for the unusual deviation in the inflation rate in 1979, the upward movements in the inflation rate fit the general upward movement in the trend rate of growth of the money stock from five percent in 1969-71 to over seven percent in 1980. The dramatic departure of the actual pattern in chart 1 arises primarily from the transitory influences of price controls and energy price changes. In addition, the steady upward trend in monetary growth, especially with the sharp accelerations in money growth in 1972-73 and again in 1976-80, pushed up the equilibrium inflation rate.

## The Monetary Policy "Dilemma"

The theory and empirical evidence concerning energy price shocks raise an apparent dilemma for policymakers. The equations above suggest that monetary policy actions can be taken to offset the temporary effects of energy price shocks on inflation and unemployment. Such a policy, however, would require large and relatively quick reversals in the path of monetary growth. Moreover, the size and timing of these switches requires attaching an extreme degree of confidence to statistical estimates of the size and timing of lagged effects of energy price changes.

An illustration of this apparent dilemma is shown in table 4, where the impact of a 40 percent once-and-for-all rise in the relative price of energy on inflation (PCE) and unemployment are shown. The rise in the relative price of energy has large and quick effects on observed inflation rates. Unemployment is initially reduced, but subsequently is raised and ultimately unaffected. Initially, the policy problem appears to require restraint, but beginning after a lag of about three quarters, unemployment rate developments appear to signal a case for monetary stimulus. This situation is short-lived as well, lasting only about two quarters. The magnitude of the effects in table 4 overstate the policy problem experienced in the past, since actual energy price increases did not occur so sharply. In the first instance (III/1973 to III/1974) the 40 percent was spread over 4 quarters and in the second (IV/1978 to I/1980), the 40 percent increase was spread over five quarters. The size of the coefficients for the first three money growth terms in the price equation is small (0.06, 0.09, and 0.10 respectively) so that massive monetary restraint would be necessary to eliminate the upward pressure on prices. For example, in table 5, the effects on inflation (PCE) and unemployment of a 40 percent annual rate of increase from quarter 0 to quarter 4 are shown. To avoid the current-quarter price surge shown there requires a cut in money growth of about 22 percentage points during that quarter. Even to eliminate the 1.5 percentage point addition to inflation in quarter 5 would require a reduction of money growth in each of the prior four quarters by about four percentage points. This in turn would create large upward pressure on unemployment during the period of positive unemployment effects associated with the energy shock.

It appears from table 5 that the unemployment effects of an energy price shock could be offset by a program of restraining money growth, then accelerating it, and again restraining monetary growth. Such an appearance is deceptive, however, because the monetary instrument is not a feasible tool for controlling unemployment. In addition, to the "accelerationist" feature of the unemployment equation (4), money exhibits "instrument instability" in the equation, so that ever larger future changes in money are required to offset the cumulative past policy effects of attempting to control unemployment with monetary policy.[12/] Thus, not only is it the case that monetary growth must occur at increasingly faster average rates to have a permanent effect reducing unemployment, it must become increasingly more variable as well.

Both adverse inflation and unemployment developments associated with an energy price shock are short-lived. A monetary policy response to such developments is likely to be destabilizing because both variables respond sluggishly to short-run policy actions. More important, the magnitude and switching of an "optimal" response is so large that it would create serious problems of monetary variability in the economy.

The results here stand in marked contrast to those of other analysts who conclude that, somehow, monetary policy could be accomodative of energy price increases without worsening the inflation rate. The fundamental flaw in such analyses is that they omit the loss in economic capacity occasioned by sharp energy price increases [see Rasche and Tatom (1977a, 1977b, and 1981) for example.] A prime example of this omission is Modigliani's argument (1977) against a constant money growth rate in the event of an energy shock. He argues (p. 16) that an unchanged growth of the money stock will lead to equilibrium if and only the price level is restored to its initial level. This is correct only if full-employment output is unaffected by an energy price increase. With such an effect, a constant growth rate of money simply "accomodates" the short-term surge in prices due to higher energy prices and accomodates a quick return to full-employment (assuming, as in 1973 and 1978, the economy is reasonably close to full-employment at the outset).

Modigliani concludes that a neutral policy implies money growth that is "too small for some initial period and too large thereafter" (p. 17). From an "optimal" viewpoint, i.e. one that ignores adverse effects due to relatively large and direction-reversing shifts in money growth, the evidence here indicates that a constant growth rate is initially too large for some initial period, then too slow, and within a very short period, appropriate for maintaining the growth rate of prices envisioned by policymakers before an energy price shock. Also, during the transitional movements of inflation and employment due to higher energy prices, recessionary monetary policy response will have little or no effect on the price level surge and will only worsen the near term prospects for unemployment, prospects that are, in turn, very short lived. No doubt Modigliani is correct that stabilization policies can be useful and desirable. In the case of energy shocks, however, there is little useful role for stimulative policies.

## Conclusion

Major supply disruptions in the U.S. economy, as well as changing theoretical perspectives, have obscured the understanding and observations of the inflation - unemployment trade-off in the last decade. The price control experience early in the seventies and two major energy price shocks temporarily affected measured inflation rates and the latter temporarily affected unemployment rates. Further distorting observations was a tendency for the full-employment unemployment rate to rise over the decade.

This paper has shown that when the effects of these unusual developments are removed from the data, a more normal trade-off relation emerges, although with inflation and unemployment rates at higher levels than experienced earlier. This relationship is all the more interesting since it emerges from a theory of inflation in which slack has no independent influence.

Recently, Tobin offered a view of the PC in the past decade that suggests the problems involve a highly variable level of unemployment at which a long-run PC is vertical and the absence of an "equilibrium" inflation rate along a long-run PC. Such a view allows any possible PC configuration and suggests that the PC is as elusive as the original concepts underlying it. It is not possible to refute such an hypothesis. In light of the results here, however, it is possible to conclude that the observational content of the trade-off view is not very elusive, despite the absence of the systematic structural relationship between inflation and unemployment called the Phillips curve.

The central policy conclusion of this paper is that there is a systematic trade-off between inflation and unemployment that constrains policy efforts to restrain inflation or promote high employment conditions. Gradual variations in money growth are likely to succeed in reducing inflation without bringing about counter-productive large temporary surges in the unemployment rate. Aggressive short-run stabilization efforts have been unnecessary in the case of the two major energy shocks of the prior decade and have been self-defeating. More important, there are no anti-inflation gains from slack *per se*, the underlying inflation rate is only reduced by slower rates of monetary expansion. The more aggressive this restriction in money growth is, the larger is the economic loss (haste makes waste) and, if the historical data are any guide, the more likely that the program of monetary restraint will be abandoned.

# FOOTNOTES

[1]There are many other unresolved issues surrounding the Phillips Curve and its estimation. For a review of these issues, especially issues concerning the microfoundations of the Phillips curve, see Seater and Santomero (1978) and Gordon (1976).

[2]Carlson (1981) discusses the questionable implications of this approach, including its implications for monetary policy.

[3]Perry (1980) appears to agree with this theme, and attempts to validate it by modeling the "inflationary bias" of the U.S. economy in a vintage 1970 model augmented by a new wage-setting dummy variable.

[4]The results are identical to the difference of the full simulation (including control effects) and the full simulation with the energy price changes set equal to zero because the model is linear.

[5]Perry's depiction of a monetarist model also appears to be incorrect, although he may have an uncited source in mind. In particular, he states that monetarist models assert that money growth determines prices rather than output even in the relatively short-run and that exogenous price shocks affect relative prices rather than the average price level. Concerning the first charge, monetarist models generally have the property that money growth influences both output and prices in the short run and only prices in the long run, although some models may allow long run aggregate supply and therefore output to be inversely related to money growth in the long run. Concerning the second charge, at least in my own work, a rise in the relative price of energy leads to a decline in potential output. A given money stock then becomes less valuable relative to the flow of goods available. Perhaps this is simply a terminology dispute because the relative price that rises is that of all goods measured in units of money, Perry's "average price level."

[6]When the PCE inflation equationis estimated including only the inverse of excess unemployment, lagged dependent variable and a constant, for the two periods examined by Perry, the slack variable is insignificant (the t-statistic equals 0.44 for the period IV/1954 to IV/1979 and -0.21 for the period IV/1954 to IV/1969). The standard error is 1.29 for the shorter period and 1.43 for the longer period. In both cases, the coefficient for the lagged dependent variable is not significantly different from one.

[7]When the decontrol dummy is allowed to end in quarters from II/1973 to I/1975, the minimum standard error of the equation below occurs when decontrol effects end in IV/1974 (S.E. = 1.18). The coefficient on D1 is -1.803(t=-2.62) and on D2 is 1.482(t=1.97), so both are significantly different from zero at the 95 percent confidence level. When the tests reported below are conducted using this specification of control effects the results are identical. It is still the case that control effects sum to zero but the decontrol lag is shorter.

[8]Gordon (1981) has made the same point. He also discusses a "reduced-form" price equation that includes, in addition to long-lags on monetary growth and control variables, such variables as social security taxes, the effective minimum wage, food and energy prices, movements in the trade-weighted foreign exchange rate, productivity deviations, the level of excess unemployment and its change, and long lags on past inflation. Many of these variables are insignificant. In addition, for the period and inflation measures examined here, none of his additional variables add significantly to the explanatory power of the equations, except for the foreign exchange rate. Improvements in the exchange value of the dollar significantly reduce inflation when such a variable is added to equations (1) and (2). This variable is omitted here, since it presumably is endogenously determined by such factors as monetary growth.

[9]Nelson (1981) provides tests indicating that the dynamic Phillips curve is consistent with an adjustment lag hypothesis, such as that used here, and not with the information lag hypothesis. The lag structure of the effect of the growth rate of nominal spending on the unemployment rate is nine quarters virtually the same as that found in Tatom (1981) for lagged money growth. Unlike Nelson, equations such as that presented below provide strong evidence of neutrality instead of a positively sloping long-run PC.

[10]A test of whether high-employment Federal expenditure growth was a significant variable rejected the hypothesis.

[11]This chart is constructed using the energy price coefficients constrained to sum to zero [see Tatom (1981) for a discussion of this equation]. The constrained equation estimate is virtually the same as that above.

[12]This problem was brought to my attention by Robert Rasche. Halbrook (1972) suggests the use of the Schur theorem to evaluate stability. Such an evaluation yields the instability result immediately. In particular, the value of the square of the coefficient on money lagged fourteen quarters less the square of the current quarter coefficient is negative, while the theorem requires that such an expression must be positive for stability. Halbrook points out that partial adjustment of the policy instrument will avoid the instability but at a cost of goal variability. Fortunately, even such a program is unnecessary since monetary policy has no long-run effect on unemployment and a given optimal money growth rate is compatible with the natural rate of unemployment.

TABLE 1

Annual Rate of Increase in GNP Deflator

| Year | Actual Inflation Rate | Monetary Inflation Rate | Control Effect | Energy Price Effect | Unexplained |
|---|---|---|---|---|---|
| 1970 | 5.4% | 4.9% | 0% | 0% | 0.5% |
| 1971 | 5.0 | 5.3 | -0.4 | 0.3 | -0.2 |
| 1972 | 4.1 | 5.9 | -1.9 | 0.1 | 0 |
| 1973 | 5.7 | 6.4 | -0.5 | 0.1 | -0.3 |
| 1974 | 8.8 | 6.2 | 1.3 | 1.4 | -0.1 |
| 1975 | 9.2 | 5.8 | 0.8 | 2.2 | 0.4 |
| 1976 | 5.2 | 5.6 | 0 | 0.4 | -0.8 |
| 1977 | 5.8 | 5.8 | 0 | 0.4 | -0.4 |
| 1978 | 7.3 | 6.3 | 0 | 0.4 | 0.6 |
| 1979 | 8.5 | 7.0 | 0 | 0.1 | 1.4 |
| 1980 | 9.0 | 7.2 | 0 | 2.0 | -0.2 |

TABLE 2

Equation 4: The Unemployment Equation
(I/1955 - IV/1980)

Dependent Variable: $UN_t$

| Independent Variable | Coefficient | t-statistic |
|---|---|---|
| $\dot{M}_t$ | -0.038 | -4.90 |
| $\dot{M}_{t-1}$ | -0.026 | -5.05 |
| $\dot{M}_{t-2}$ | -0.016 | -3.95 |
| $\dot{M}_{t-3}$ | -0.008 | -1.99 |
| $\dot{M}_{t-4}$ | -0.001 | -0.18 |
| $\dot{M}_{t-5}$ | 0.005 | 1.41 |
| $\dot{M}_{t-6}$ | 0.009 | 2.99 |
| $\dot{M}_{t-7}$ | 0.012 | 4.37 |
| $\dot{M}_{t-8}$ | 0.013 | 4.78 |
| $\dot{M}_{t-9}$ | 0.014 | 4.23 |
| $\dot{M}_{t-10}$ | 0.013 | 3.47 |
| $\dot{M}_{t-11}$ | 0.012 | 2.83 |
| $\dot{M}_{t-12}$ | 0.010 | 2.34 |
| $\dot{M}_{t-13}$ | 0.007 | 1.96 |

TABLE 2
(continued)

| Independent Variable | Coefficient | t-statistic |
|---|---|---|
| $\dot{M}_{t-14}$ | 0.004 | 1.67 |
| $\sum_{i=0}^{14} \dot{M}_{t-15}$ | 0.011 | 1.29 |
| $\dot{p}^e_{t-1}$ | -0.004 | -2.08 |
| $\dot{p}^e_{t-2}$ | 0.002 | 2.33 |
| $\dot{p}^e_{t-3}$ | 0.005 | 4.22 |
| $\dot{p}^e_{t-4}$ | 0.004 | 3.27 |
| $\dot{p}^e_{t-5}$ | -0.001 | -0.78 |
| $\dot{p}^e_{t-6}$ | -0.010 | -4.52 |
| $\sum_{j=1}^{6} \dot{p}_{t-j}$ | -0.003 | 0.63 |
| $UN_{t-1}$ | 1.277 | 11.56 |
| $UN_{t-2}$ | -0.277 | -3.32 |

$R^2 = 0.62$ S.E. = 0.249 D.W. = 1.92 $\hat{\rho} = 0.18$ h = 0.77

TABLE 3

Change in the Civilian Unemployment Rate

| | Actual | Due To Monetary Growth Changes | Due To Energy Price Changes | Due To Others Factors* |
|---|---|---|---|---|
| 1970 | 1.4% | 1.3% | 0.0% | 0.1% |
| 1971 | 1.0 | 0.5 | 0.2 | 0.3 |
| 1972 | -0.4 | -0.7 | 0.0 | 0.3 |
| 1973 | -0.7 | -0.7 | -0.1 | 0.1 |
| 1974 | 0.7 | 1.0 | 0.0 | -0.3 |
| 1975 | 2.8 | 1.6 | 0.5 | 0.7 |
| 1976 | -0.8 | 0.6 | -1.2 | -0.2 |
| 1977 | -0.7 | -0.6 | -0.2 | 0.1 |
| 1978 | -1.1 | -0.9 | 0.1 | -0.3 |
| 1979 | -0.2 | -0.2 | -0.4 | -0.3 |
| 1980 | 1.4 | 0.9 | 0.5 | 0.0 |

*Includes changes in full-employment rate rounding error and residual error.

TABLE 4

The Effects of a 40 Percent Rise in the Relative Price of Energy on Consumer Price Inflation and Unemployment

| Quarter | $\dot{P}$ | U |
|---|---|---|
| 0 | 6.3 | 0 |
| 1 | 2.0 | -0.9 |
| 2 | 5.7 | -0.5 |
| 3 | 0 | 0.2 |
| 4 | 0 | 1.3 |
| 5 | 0 | 1.8 |
| 6 | 0 | 0 |

TABLE 5

Effect of a 40 Percent Increase in the Relative Price of Energy over 4 Quarters on Inflation (PCE) and Unemployment

| Quarter | $\dot{P}$ | U |
|---|---|---|
| 0 | 1.3 | 0.0 |
| 1 | 1.8 | -0.2 |
| 2 | 3.2 | -0.4 |
| 3 | 3.2 | -0.3 |
| 4 | 1.9 | 0 |
| 5 | 1.4 | 0.7 |
| 6 | 0 | 0.8 |
| 7 | 0 | 0.8 |
| 8 | 0 | 0.4 |
| 9 | 0 | 0 |

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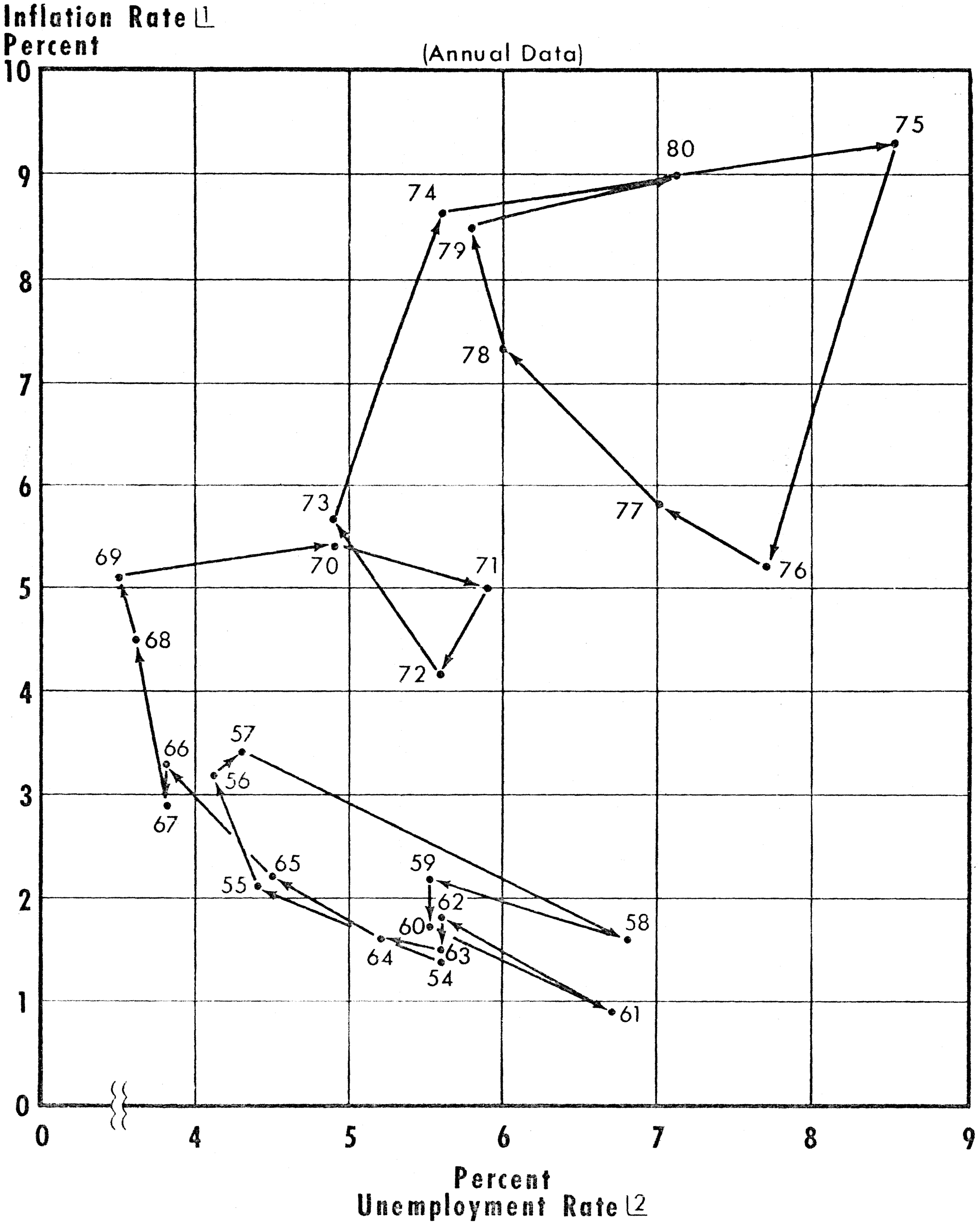
CHART 1

# Inflation and Unemployment
## 1954–1980




Sources: U.S. Department of Commerce and U.S. Department of Labor

1 Percentage Change in the GNP Implicit Price Deflator.

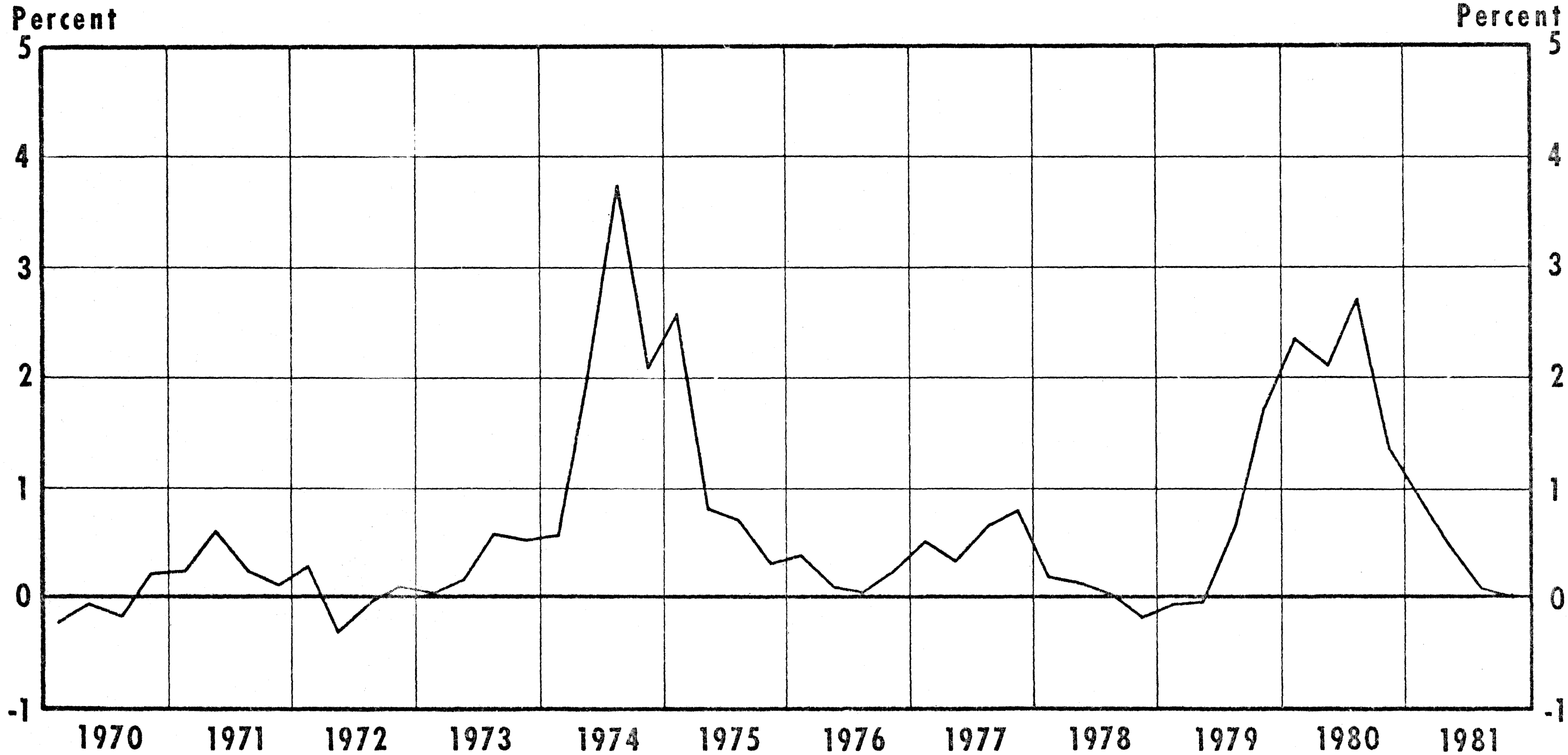
2 Percent of Civilian Labor Force.

Latest data plotted: 1980

Prepared by Federal Reserve Bank of St. Louis

CHART 2

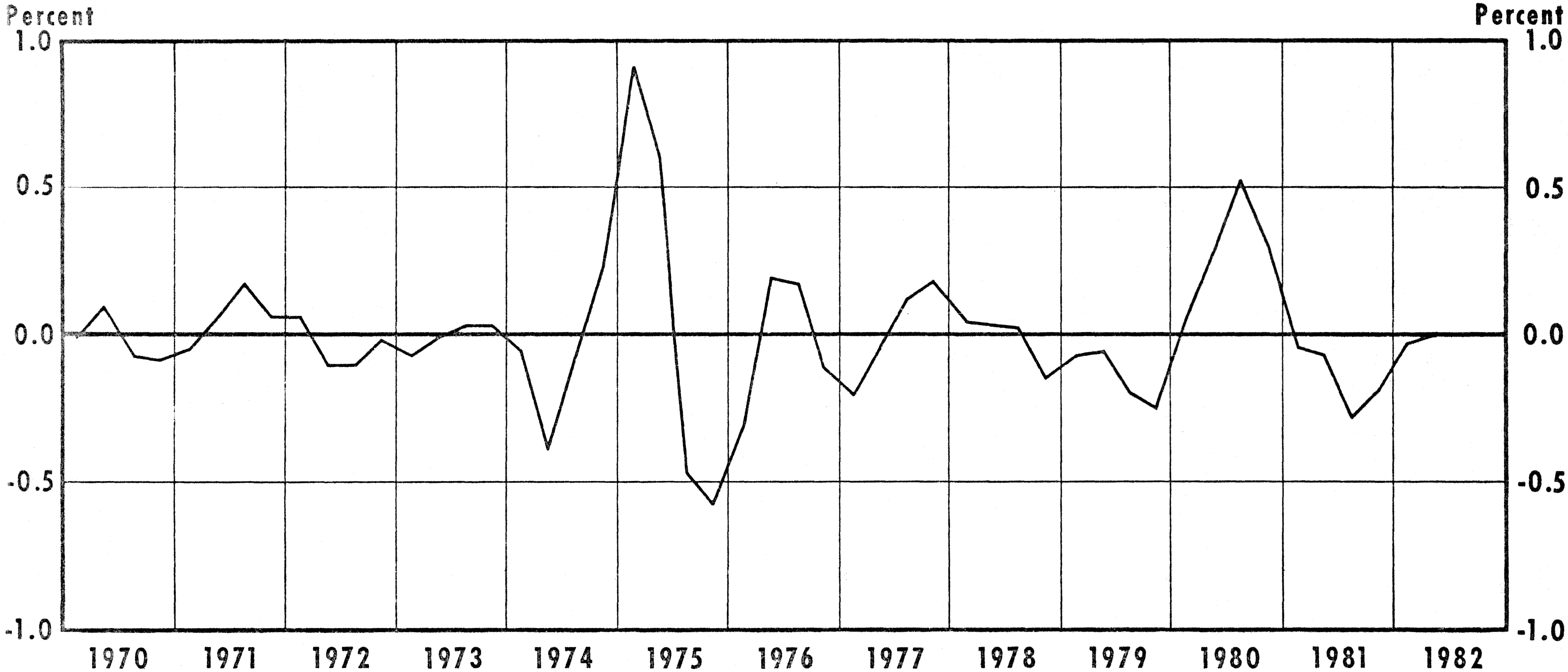
# Contribution of Energy Price Changes (I/1970—III/1980) to the Rate of Increase of Prices [1]




[1] Percentage changes are measured by changes in the logarithm of the level of the gross national product deflator.
Latest data plotted: 4th quarter

CHART 3

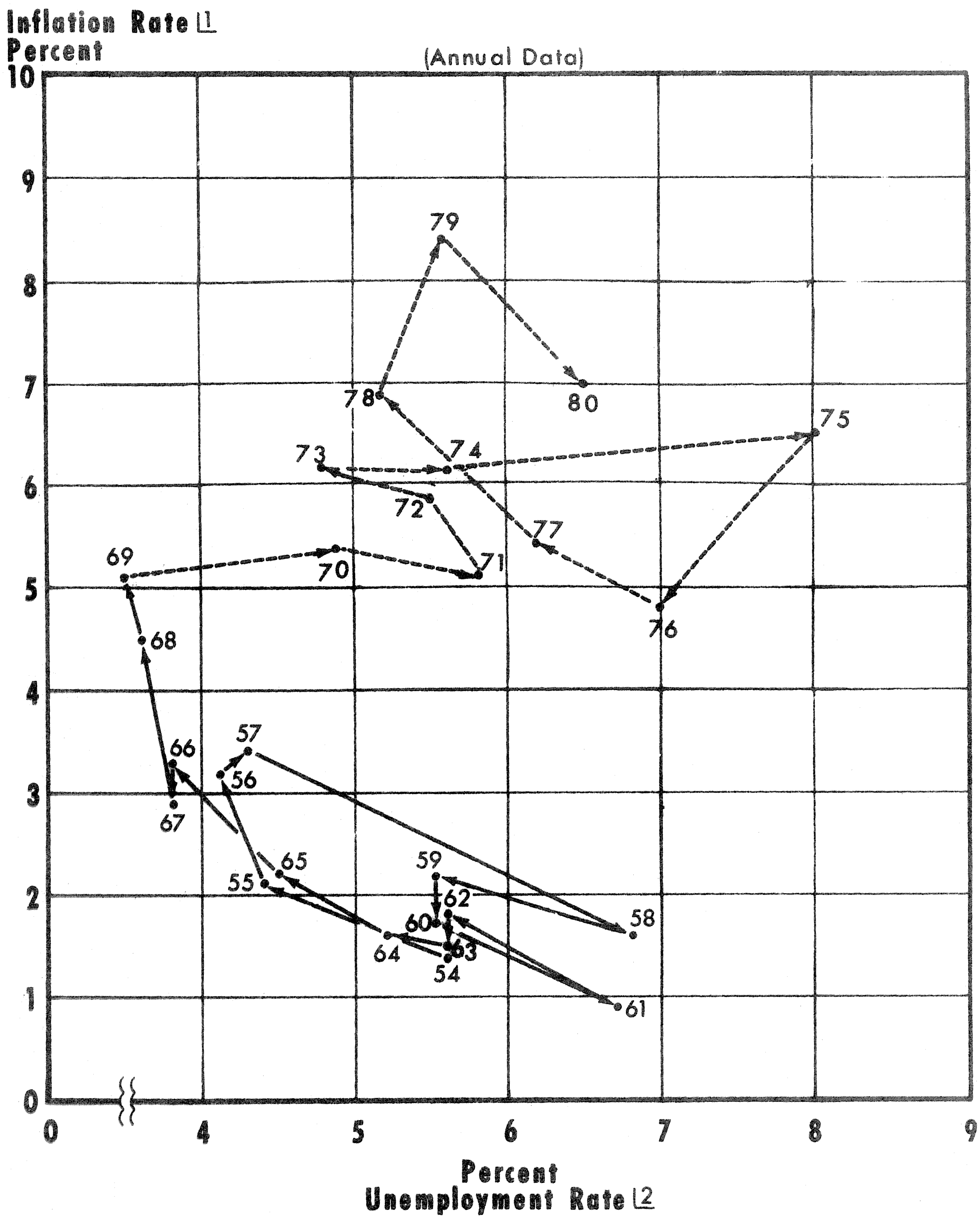
## Portion of the Change in the Unemployment Rate Due to Energy Price Changes (I/1970—III/1980)




Latest data plotted: 4th quarter

CHART 4

# Inflation and Unemployment Without Energy Price Effects: 1970-1980




Sources: U.S. Department of Commerce and U.S. Department of Labor

[1] Percentage Change in the GNP Implicit Price Deflator.

[2] Percent of Civilian Labor Force.

Latest data plotted: 1980

Prepared by Federal Reserve Bank of St. Louis